**CAMBRIDGE INTERNATIONAL EXAMINATIONS**
**Cambridge International Advanced Subsidiary Level**

# MARK SCHEME for the October/November 2015 series

## 9709 MATHEMATICS

**9709/21** Paper 2, maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2015 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.



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**Mark Scheme Notes**

Marks are of the following three types:

M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

B Mark for a correct result or statement independent of method marks.

- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

- The symbol √ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.

- Note: B2 or A2 means that the candidate can earn 2 or 0.
  B2/1/0 means that the candidate can earn anything from 0 to 2.

  The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking *g* equal to 9.8 or 9.81 instead of 10.

The following abbreviations may be used in a mark scheme or used on the scripts:

AEF Any Equivalent Form (of answer is equally acceptable)

AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

BOD Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)

CAO Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)

CWO Correct Working Only – often written by a 'fortuitous' answer

ISW Ignore Subsequent Working

MR Misread

PA Premature Approximation (resulting in basically correct work that is insufficiently accurate)

SOS See Other Solution (the candidate makes a better attempt at the same question)

SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

**Penalties**

MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through √" marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR–2 penalty may be applied in particular cases if agreed at the coordination meeting.

PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

| | | | | |
|---|---|---|---|---|
| **1** | | Introduce logarithms and use power law twice | **M1*** | |
| | | Obtain $(x+3)\log 5 = (x-1)\log 7$ or equivalent | **A1** | |
| | | Solve linear equation for $x$ | **M1 dep** | |
| | | Obtain 20.1 | **A1** | [4] |
| **2** | | Use quotient rule or, after adjustment, product rule | **M1*** | |
| | | Obtain $\dfrac{3x-15-3x-1}{(x-5)^2}$ or equivalent | **A1** | |
| | | Equate first derivative to –4 and solve for $x$ | **M1 dep** | |
| | | Obtain $x$-coordinates 3 and 7 or one correct pair of coordinates | **A1** | |
| | | Obtain $y$-coordinates –5 and 11 respectively or other correct pair of coordinates | **A1** | [5] |
| **3** | **(i)** | State or imply $R = 17$ | **B1** | |
| | | Use appropriate formula to find $\alpha$ | **M1** | |
| | | Obtain 61.93 | **A1** | [3] |
| | **(ii)** | Attempt to find at least one value of $\theta + \alpha$ | **M1** | |
| | | Obtain one correct value of $\theta$ (97.4 or 318.7) | **A1** | |
| | | Carry out correct method to find second answer | **M1** | |
| | | Obtain second correct value and no others between 0 and 360 | **A1** | [4] |
| **4** | **(i)** | Make a recognisable sketch of $y = \ln x$ | **B1** | |
| | | Draw straight line with negative gradient crossing positive $y$-axis and justify one real root | **B1** | [2] |
| | **(ii)** | Consider sign of $\ln x + \frac{1}{2}x - 4$ at 4.5 and 5.0 or equivalent | **M1** | |
| | | Complete the argument correctly with appropriate calculations | **A1** | [2] |
| | **(iii)** | Use the iterative formula correctly at least once | **M1** | |
| | | Obtain final answer 4.84 | **A1** | |
| | | Show sufficient iterations to justify accuracy to 2 d.p. or show sign change in interval (4.835, 4.845) | **A1** | [3] |
| **5** | **(a)** | Use $\tan^2 x = \sec^2 x - 1$ | **B1** | |
| | | Obtain integral of form $p\tan x + qx + r\cos 2x$ | **M1** | |
| | | Obtain $\tan x - x - \frac{1}{2}\cos 2x + c$ | **A1** | [3] |

| | | | | |
|---|---|---|---|---|
| | **(b)** | Obtain integral of form $ke^{1-2x}$ | **M1*** | |
| | | Obtain $-\frac{3}{2}e^{1-2x}$ | **A1** | |
| | | Apply both limits the correct way round | **M1 dep** | |
| | | Obtain $-\frac{3}{2}e^{-1}+\frac{3}{2}e$ or exact equivalent | **A1** | [4] |
| **6** | **(i)** | Carry out division at least as far as quotient $x^2+kx$ | **M1** | |
| | | Obtain partial quotient $x^2+2x$ | **A1** | |
| | | Obtain quotient $x^2+2x+1$ with no errors seen | **A1** | |
| | | Obtain remainder $5x+2$ | **A1** | [4] |
| | **(ii)** | <u>Either</u> Carry out calculation involving $12x+6$ and their remainder $ax+b$ | **M1** | |
| | | Obtain $p=7, q=4$ | **A1** | |
| | | <u>Or</u> Multiply $x^2-x+4$ by their three-term quadratic quotient | **M1** | |
| | | Obtain $p=7, q=4$ | **A1** | [2] |
| | **(iii)** | Show that discriminant of $x^2-x+4$ is negative | **B1** | |
| | | Form equation $(x^2-x+4)(x^2+2x+1)=0$ and attempt solution | **M1** | |
| | | Show that $x^2+2x+1=0$ gives one root $x=-1$ | **A1** | [3] |
| **7** | **(i)** | Obtain $12\sin t\cos t$ or equivalent for $\frac{dx}{dt}$ | **B1** | |
| | | Obtain $4\cos 2t-6\sin 2t$ or equivalent for $\frac{dy}{dt}$ | **B1** | |
| | | Obtain expression for $\frac{dy}{dx}$ in terms of $t$ | **M1** | |
| | | Use $2\sin t\cos t=\sin 2t$ | **A1** | |
| | | Confirm given answer $\frac{dy}{dx}=\frac{2}{3}\cot 2t-1$ with no errors seen | **A1** | [5] |
| | **(ii)** | State or imply $\tan 2t=\frac{2}{3}$ | **B1** | |
| | | Obtain $t=0.294$ | **B1** | |
| | | Obtain $t=1.865$ | **B1** | [3] |
| | **(iii)** | Attempt solution of $2\sin 2t+3\cos 2t=0$ at least as far as $\tan 2t=\ldots$ | **M1** | |
| | | Obtain $\tan 2t=-\frac{3}{2}$ or equivalent | **A1** | |
| | | Substitute to obtain $-\frac{13}{9}$ | **A1** | [3] |